

VERIFICATION OF TRANSLATION

I, Michiyo AONO, of c/o Sudo International Patent Office,
Shinyo Bldg. 6F, 6-1, Nihonbashi-Muromachi 1-chome,
Chuo-ku, Tokyo 103-0022 JAPAN
am translator of Japanese Patent Application No. 2002-246318
and I state that the following is an accurate translation to
the best of my knowledge and belief.

(Signature of Translator)

Michiyo Aono

(Dated)

November 10, 2008

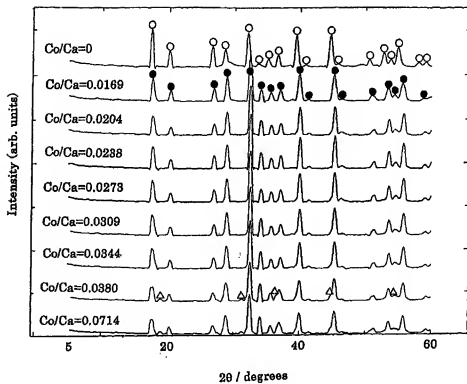


Fig 1

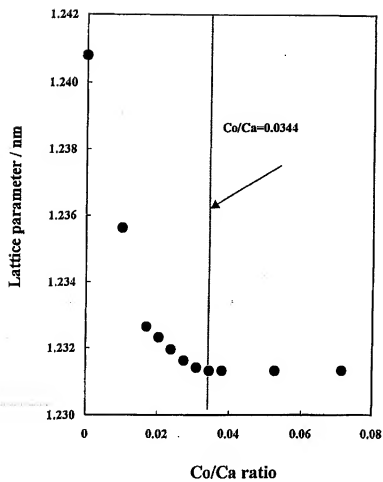


Fig 2

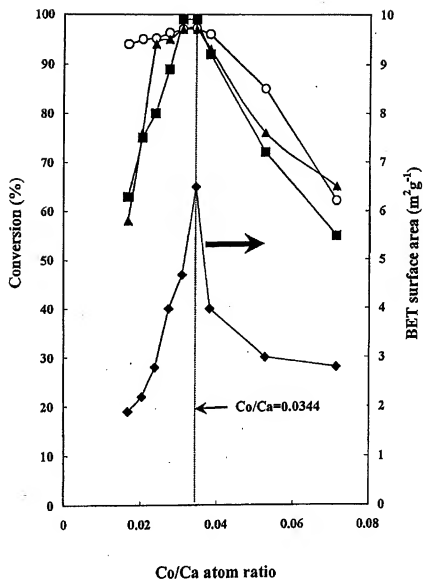


Fig 3

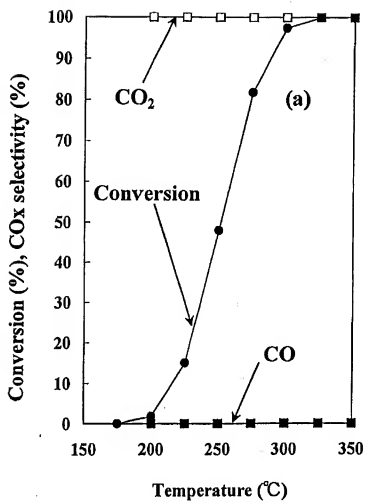


Fig 4

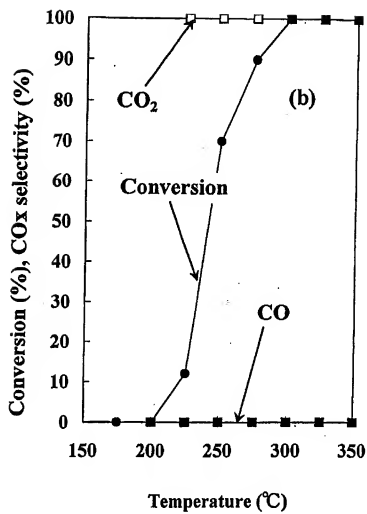


Fig 5

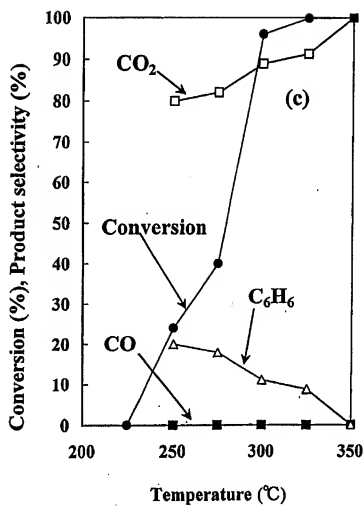


Fig 6

[Name of Document] Specification

[Title of Invention] Mayenite catalyst supporting cobalt oxide and method thereof

[Claims]

[Claim 1] A mayenite catalyst supporting cobalt oxide, which is an oxidation or combustion catalyst containing as a constituent component a mayenite that includes or occludes active oxygen in its structure, wherein the cobalt oxide is carried on the mayenite surface.

[Claim 2] The mayenite catalyst supporting cobalt oxide according to Claim 1, wherein a mayenite has a compositional formula of $(\text{Ca}_{3-x}\text{Co}_x)\text{Al}_2(\text{SiO}_4)_{3-y}(\text{OH})_y$, where the value of X is in the range of $0 < X \leq 0.10$, Y is in the range of $0 \leq Y \leq 2.2$.

[Claim 3] A method for manufacturing the mayenite catalyst supporting cobalt oxide according to Claim 1, wherein cobalt-containing hydrogarnet is decomposed by heating.

[Claim 4] The method for manufacturing a mayenite catalyst supporting cobalt oxide according to Claim 3, wherein the cobalt-containing hydrogarnet has a compositional formula of $(\text{Ca}_{3-x}\text{CO}_x)\text{Al}_2(\text{SiO}_4)_{3-y}(\text{OH})_y$, where

the value of X is in the range of $0 < X \leq 0.10$, and Y in the range of $0 \leq Y \leq 2.2$.

【Claim 5】 The method for manufacturing a mayenite catalyst supporting cobalt oxide according to Claim 3, wherein the cobalt-containing hydrogarnet is heated at no lower than 300°C and no higher than 1000°C.

【Claim 6】 An oxidative decomposition method, wherein a material to be treated typified by a volatile organic compound is oxidatively decomposed using the mayenite catalyst supporting cobalt oxide according to Claim 1 or 2.

[Detailed Description of the Invention]

[0001]

[Field of Industrial Application]

The present invention also relates to a mayenite catalyst supporting cobalt oxide, to a method for manufacturing this catalyst, and to applications for this catalyst, and more particularly relates to a mayenite catalyst supporting cobalt oxide that has more active oxidation capability at lower temperatures than conventional oxidation or combustion catalysts, and to a method for manufacturing this catalyst, to a method for the oxidative decomposition of volatile organic compounds with this catalyst, and so forth. The mayenite that is the catalyst component of the present invention has a zeolite-like structure in which active oxygen (superoxide: O_2^- , peroxide: O_2^{2-}) is encapsulated, and can be used in oxidation reactions of hydrocarbons and the like by means of the active oxygen included in the structure. Examples of such reactions include epoxidation, complete oxidation, partial oxidation, and coupling. When cobalt oxide is supported on this mayenite, the result is a catalyst of even higher activity, and the mayenite catalyst supporting cobalt oxide of the present invention can be utilized in a wide range of

technological fields dealing with the environment, energy, the chemical industry (manufacturing process), and so forth.

[0002]

[Prior Art]

Furthermore, the release of volatile organic compounds and the like into the atmosphere today is causing serious environmental pollution. Combustion is one way that volatile organic compounds can be removed, but this requires high temperatures over 1000°C. Catalysts are utilized to allow combustion to occur at lower temperatures. The catalysts used for such applications are called combustion catalysts. In the past, oxides of cobalt, copper, manganese, chromium, and the like have been supported on porous alumina, allowing the combustion temperature to be lowered to between 300 and 600°C (see, for example, (1) Y.M. Kang and B.Z. Wan, *Appl. Cat. A*, Vol. 114 (1994), p. 35, (2) R.S. Drago, K. Jurczyk, D.L. Singh, and V. Young, *Appl. Cat. B8* (1996), p. 155, and (3) N. Watanabe, H. Yamashita, H. Miyadera, and S. Tominaga, *Appl. Cat. B8* (1996), p. 405). Today, however, the development of a catalyst with higher activity than conventional catalysts is needed for the sake of energy conservation.

[0003]

[Means for Solving the Subjects]

In the course of further diligent research aimed at developing a catalyst of higher activity in light of the above prior art, the inventors took a close look at hydrogarnet, whereupon they discovered that when it is heated to 350°C or higher, it changes into a mayenite, and this mayenite includes or occludes active oxygen such as peroxide anions and superoxide anions into its structure. These active oxygens stay in the structure at room temperature, but can move at temperatures over 400°C. Specifically, the active oxygen present in the structure fly out of the structure and induce chemical reactions such as oxidation. The inventors arrived at the present invention upon discovering for the first time that after the active oxygen moves, the oxygen in the air is taken into the structure, regenerating it, and that active oxygen can be supplied continuously and incessantly, and that active oxygen is a powerful oxidant and is extremely effective in the oxidative decomposition or combustion of volatile organic compounds and so forth, and when cobalt oxide, which has long been known as an oxidation catalyst, is supported on a mayenite that develops active oxygen, even higher oxidation capability can be imparted at low temperature.

It is an object of the present invention to develop and provide a catalyst with higher activity than conventional oxidation or combustion catalysts, and to provide a method for manufacturing this catalyst.

[0004]

[Means for Solving the Subjects]

The present application to solve the above subject is constituted by the following technical means.

(1) A mayenite catalyst supporting cobalt oxide, which is an oxidation or combustion catalyst containing as a constituent component a mayenite that includes or occludes active oxygen in its structure, wherein the cobalt oxide is carried on the mayenite surface.

(2) The mayenite catalyst supporting cobalt oxide according to (1) above, wherein a mayenite has a compositional formula of $(Ca_{3-x}Co_x)Al_2(SiO_4)_{3-y}(OH)_y$, where the value of X is in the range of $0 < X \leq 0.10$, Y is in the range of $0 \leq Y \leq 2.2$.

(3) A method for manufacturing the mayenite catalyst supporting cobalt oxide according to (1) above, wherein cobalt-containing hydrogarnet is decomposed by heating.

(4) The method for manufacturing a mayenite catalyst supporting cobalt oxide according to (3) above, wherein the cobalt-containing hydrogarnet has a compositional formula of

$(Ca_{3-x}CO_x)Al_2(SiO_4)_{3-y}(OH)_{4y}$, where the value of X is in the range of $0 < X \leq 0.10$, and Y in the range of $0 \leq Y \leq 2.2$.

(5) The method for manufacturing a mayenite catalyst supporting cobalt oxide according to (3) above, wherein the cobalt-containing hydrogarnet is heated at no lower than 300°C and no higher than 1000°C.

(6) An oxidative decomposition method, wherein a material to be treated typified by a volatile organic compound is oxidatively decomposed using the mayenite catalyst supporting cobalt oxide according to (1) or (2) above.

[0005]

[Aspect of the Invention]

Next, the present invention will now be described in further detail.

The novel catalyst of the present invention is obtained by synthesizing cobalt-containing hydrogarnet as a precursor substance by a wet heat method, and heating this product at 300°C or higher. The chemical composition thereof is expressed by $(Ca_{3-x}CO_x)Al_2(SiO_4)_{3-y}(OH)_{4y}$. The novel catalyst of the present invention is characterized in that the X value in the compositional formula is in the range of $0 < X \leq 0.10$, and Y in the range of $0 \leq Y \leq 2.2$. The novel

catalyst of the present invention can be utilized as an oxidation catalyst or the like.

The mayenite catalyst supporting cobalt oxide of the present invention is manufactured by synthesizing a cobalt-containing hydrogarnet in which some of the Ca^{2+} ions (a constituent element of hydrogarnet) have been replaced with Co^{2+} ions, and then heating and decomposing this product. To facilitate an understanding of the following description, hydrogarnet itself will first be described. Hydrogarnet has a garnet structure, and its compositional formula is $\text{Ca}_3\text{Al}_2(\text{SiO}_4)_{3-Y}(\text{OH})_{4Y}$. The value of Y here is in the range of $0 \leq Y \leq 3$. The compositional formula of hydrogarnet varies with the Y value. For instance, the formula is $\text{Ca}_3\text{Al}_2(\text{SiO}_4)_3$ when $Y = 0$, $\text{Ca}_3\text{Al}_2(\text{SiO}_4)_{1.5}(\text{OH})_6$ when $Y = 1.5$, $\text{Ca}_3\text{Al}_2(\text{SiO}_4)_{0.8}(\text{OH})_{8.8}$ when $Y = 2.2$, and $\text{Ca}_3\text{Al}_2(\text{OH})_{12}$ when $Y = 3$. The Ca^{2+} ions in the hydrogarnet structure can be substituted with other cations of similar ion radius, such as Co^{2+} ions.

[0006]

The radius of Ca^{2+} and Co^{2+} ions is 0.112 and 0.090 nm, respectively, with the latter being slightly smaller. Therefore, when Ca^{2+} ions are substituted with Co^{2+} ions, the lattice constant of the hydrogarnet becomes somewhat smaller. There is a limit to the amount of substitution of Ca^{2+} ions

versus Co^{2+} ions, and when this limit was calculated experimentally, it was found to be $\text{Co/Ca} = 0.0344$ (= $0.10/2.90$ molar ratio). When the Co/Ca molar ratio is 0.0344 , the compositional formula of hydrogarnet is $(\text{Ca}_{2.9}\text{Co}_{0.1})\text{Al}_2(\text{SiO}_4)_{3-Y}(\text{OH})_{4Y}$. The added amount of cobalt may be increased, but as discussed below, this decreases catalyst activity, so it is better not to add too much cobalt (so that the Co/Ca molar ratio would be over 0.0344).

[0007]

The method for manufacturing the mayenite catalyst supporting cobalt oxide of the present invention will now be described, but this is not intended to limit the method for manufacturing the mayenite catalyst supporting cobalt oxide of the present invention. The cobalt-containing hydrogarnet used as a precursor of the mayenite catalyst supporting cobalt oxide is prepared as follows. First, a cobalt source, a calcia source, an alumina source, and a silica source are mixed so as to match the hydrogarnet composition, that is, the composition of cobalt-containing hydrogarnet with the desired X and Y values, and an excess of water is added to this to prepare a mixture. The cobalt source here can be cobalt hydroxide, cobalt oxide, or the like; the calcia source can be slaked lime, unslaked lime, calcium carbonate, gypsum, or the like; the alumina source can be kaolin,

alumina sol, boehmite, aluminum hydroxide, aluminum oxide, or the like; and the silica source can be kaolin, silica, amorphous silica, diatomaceous earth, silica sand, quartz, or the like. These are not the only sources that can be used, however, and any that have the same effect as these can also be used. The combined amount of cobalt and calcium is set to be "3" in the compositional formula $(Ca_{3-x}Co_x)Al_2(SiO_4)_{3-y}(OH)_{4y}$. Preferably, the range is $0 < x \leq 0.10$. The Y value is preferably in the range of $0 \leq y \leq 2.2$.

[0008]

The prepared mixture is subjected to a wet heat treatment in an autoclave for at least 5 hours at a temperature of from 100 to 200°C to synthesize cobalt-containing hydrogarnet. The reaction will not proceed adequately if the temperature is below 100°C, but too much thermal energy will be consumed if the temperature is over 200°C, so 100 to 200°C is the preferred range. The heating time can be shorter than 5 hours, but at least 5 hours is preferable in order to obtain cobalt-containing hydrogarnet with good crystallinity. Further, a mayenite catalyst supporting cobalt oxide in which the cobalt oxide is highly dispersed can be manufactured by heating the cobalt-

containing hydrogarnet to between 300°C and 1000°C in an air atmosphere. The decomposition of the cobalt-containing hydrogarnet will be inadequate if the heating is at a temperature below 300°C, and while the heating may be performed at a temperature over 1000°C, this is undesirable from the standpoint of conserving energy.

【0009】

The ion used for substitution need not be limited to cobalt, and any other ion that can be substituted may be used instead. It is well known that a high-performance catalyst in which the catalyst particles are highly dispersed can be synthesized by substituting metal ions in the crystal structure and pyrolyzing. This catalyst manufacturing method is a proven technology in the case of using a layered double hydroxide (LDH) as a catalyst precursor (see, for example, F. Cavani, F. Trifiro, and A. Vaccari, *Catal. Today*, Vol. 11 (1991), p. 173; B. Chen and J.L. Falconer, *J. Catal.*, Vol. 144 (1993), p. 214; S. Velu, R. Veda, A. Ramani, B.M. Chenda, and S. Sivasanker, *Chem. Commun.* (1997), p. 2107; S. Velu, K. Suzuki, M.P. Kapoor, F. Ohashi, and T. Osaki, *Appl. Catal. A*, Vol. 213 (2001), p. 47; and S. Velu, K. Suzuki, and T. Osaki, *Catal. Lett.*, Vol. 69 (2000), p. 43), but the inventors of the present

invention are the first to discover the catalyst of the present invention in which a cobalt-containing hydrogarnet having a garnet structure is used as a catalyst precursor, and the method for manufacturing this substance.

[0010]

Next, the amount of Co^{2+} ions that can be substituted in this hydrogarnet with the method of the present invention will be described, using as an example a hydrogarnet in which $Y = 2.2$. Fig. 1 shows the XRD results for cobalt-containing hydrogarnet synthesized by the above method, with the Co/Ca ratio varied from 0 to 0.0714. In Fig. 1, the white circles are the diffraction peaks originating in hydrogarnet $(\text{Ca}_3\text{Al}_2(\text{SiO}_4)_{0.8}(\text{OH})_{8.8})$, the black circles are those originating in cobalt-containing hydrogarnet $((\text{Ca}_{3-x}\text{Co}_x)\text{Al}_2(\text{SiO}_4)_{0.8}(\text{OH})_{8.8})$, and the triangles are those originating in cobalt oxide (Co_3O_4). Hydrogarnet alone was synthesized for the sample with no added cobalt (Co/Ca = 0). It was confirmed that when some of the calcium was substituted with cobalt (Co/Ca = 0.0169), the lattice constant was smaller, so the diffraction line angle shifted higher, producing cobalt-containing hydrogarnet. When the amount of added cobalt was increased to Co/Ca = 0.0380, there was precipitation of cobalt oxide that could not be substituted.

[0011]

Therefore, the limit to the amount of cobalt that can be substituted is $\text{Co/Ca} = 0.0344$. As mentioned above, the compositional formula here is $(\text{Ca}_{2.9}\text{Co}_{0.1})\text{Al}_2(\text{SiO}_4)_{0.8}(\text{OH})_{0.8}$. The results in Fig. 1 were used to plot the graph of Fig. 2, which shows the relationship between lattice constant and Co/Ca ratio. Up to a Co/Ca ratio of 0.0344, the lattice constant steadily decreases from 1.2408 nm to 1.2313 nm, after which it remains at 1.2313 nm until the Co/Ca ratio is 0.0714. This means that all of the Co^{2+} ions added are being used in substitution up to a Co/Ca ratio of 0.0344, and that beyond this ratio (that is, when the Co/Ca ratio is over 0.0344), no substitution is being performed. The above results are compiled in Table 1.

[0012]

[Table 1]

Lattice constants of cobalt-containing hydrogarnet
 $[(\text{Ca}_{2-x}\text{Co}_x)\text{Al}_2(\text{SiO}_4)_{0.8}(\text{OH})_{0.8}]$: $0 \leq x \leq 0.10$

Co/Ca	X	Compositional formula	a/nm	V/nm ³
0	0	$\text{Ca}_3\text{Al}_2(\text{SiO}_4)_{0.8}(\text{OH})_{0.8}$	1.24078 (15)	1.910
0.0101	0.03	$(\text{Ca}_{2.97}\text{Co}_{0.03})\text{Al}_2(\text{SiO}_4)_{0.8}(\text{OH})_{0.8}$	1.23563 (6)	1.886
0.0169	0.05	$(\text{Ca}_{2.95}\text{Co}_{0.05})\text{Al}_2(\text{SiO}_4)_{0.8}(\text{OH})_{0.8}$	1.23263 (6)	1.872
0.0204	0.06	$(\text{Ca}_{2.94}\text{Co}_{0.06})\text{Al}_2(\text{SiO}_4)_{0.8}(\text{OH})_{0.8}$	1.23231 (7)	1.871
0.0238	0.07	$(\text{Ca}_{2.93}\text{Co}_{0.07})\text{Al}_2(\text{SiO}_4)_{0.8}(\text{OH})_{0.8}$	1.23196 (6)	1.869
0.0273	0.08	$(\text{Ca}_{2.92}\text{Co}_{0.08})\text{Al}_2(\text{SiO}_4)_{0.8}(\text{OH})_{0.8}$	1.23162 (12)	1.868
0.0309	0.09	$(\text{Ca}_{2.91}\text{Co}_{0.09})\text{Al}_2(\text{SiO}_4)_{0.8}(\text{OH})_{0.8}$	1.23141 (13)	1.867
0.0344	0.10	$(\text{Ca}_{2.90}\text{Co}_{0.10})\text{Al}_2(\text{SiO}_4)_{0.8}(\text{OH})_{0.8}$	1.23131 (10)	1.866

[0013]

The relationship between the products and the heating temperature was further examined by XRD for $(\text{Ca}_{2.9}\text{Co}_{0.1})\text{Al}_2(\text{SiO}_4)_{0.8}(\text{OH})_{8.8}$, which revealed that there was no change (remained as $(\text{Ca}_{2.9}\text{Co}_{0.1})\text{Al}_2(\text{SiO}_4)_{0.8}(\text{OH})_{8.8}$) from room temperature up to 300°C, but heating at 350°C resulted in a change into mayenite hydroxide $(\text{Ca}_{12}\text{Al}_{10}\text{Si}_4\text{O}_{32}(\text{OH})_6)$, unslaked lime (CaO), and cobalt oxide (Co_3O_4). The products of heating at over 350°C were mayenite hydroxide, unslaked lime, and cobalt oxide in every case. When the heating was performed at over 700°C, the mayenite hydroxide was further dehydrated into anhydrous mayenite $(\text{Ca}_{12}\text{Al}_{10}\text{Si}_4\text{O}_{35})$.

[0014]

Table 2 shows the specific surface area and the cobalt oxide particle size when four types of cobalt-containing hydrogarnet were synthesized with different Co/Ca ratios of 0.0169, 0.0238, 0.0344, and 0.0714, and then heated at 400°C. The specific surface area was at its maximum of 6.5 m²/g when the hydrogarnet had a Co/Ca ratio of 0.0344, and was about 2 to 3 m²/g with other hydrogarnets. Meanwhile, the cobalt oxide particle size was substantially the same as the 250 to 275 Å of cobalt-containing hydrogarnet with a Ca/Co ratio of from 0.0169 to 0.0344, and increased to 850 Å at Co/Ca = 0.0714. A larger cobalt oxide particle size is

undesirable because it leads to a decrease in dispersibility, that is, a decrease in catalyst activity, so the particle size of the cobalt oxide needs to be as small as possible.

[0015]

[Table 2]

Specific surface area and cobalt oxide particle size of four types of cobalt-containing hydrogarnet (with different Co/Ca ratios of 0.0169, 0.0238, 0.0344, and 0.0714) after heating at 400°C.

Co/Ca	0.0169	0.0238	0.0344	0.0714
X	0.05	0.07	0.10	-
Specific surface area (m ² /g)	1.9	2.8	6.5	2.9
Co ₃ O ₄ particle size (Å)	250	260	275	850

[0016]

Table 3 shows the relationship of specific surface area and cobalt oxide particle size to the heating temperature of cobalt-containing hydrogarnet with a Co/Ca ratio of 0.0344. The specific surface area was roughly the same (5.7 and 6.5 m²/g) after heating at 350 and 400°C, but decreased steadily after heating at 450°C and above. Meanwhile, the cobalt oxide particle size was roughly the same (260 and 275 Å) after heating at 350 and 400°C, but increased steadily from 447 Å after heating at 450°C and above. The above results indicate that a Co/Ca ratio of 0.0344 and a heating temperature of 400°C or lower are preferable for manufacturing a mayenite catalyst supporting cobalt oxide.

[0017]

[Table 3]

Specific surface area, cobalt oxide particle size, and heating temperature of cobalt-containing hydrogarnet with Co/Ca of 0.0344.

Heating temp. (°C)	350	400	450	500	600
Specific surface area (m ² /g)	5.7	6.5	4.2	3.5	2.4
Co ₃ O ₄ particle size (Å)	260	275	447	489	856

[0018]

We will now describe the method for examining the catalytic activity of the mayenite catalyst supporting cobalt oxide. The reaction apparatus was a normal pressure, compact, fixed bed, flow through type. The catalyst particle size was 300 to 500 μm , the reaction temperature was from room temperature to 500°C, three types of reaction gas (propylene, benzene, and toluene) were used, the reaction gas concentration was 1000 ppm, the flow-through gas was air, the gas flux was 100 mL/min, the space velocity was 10,000 h⁻¹, and gas analysis was performed by gas chromatography (packing material: Porapak P, 5A molsieve, activated carbon, column: 2 m x 3). Fig. 3 shows the relationship between the Co/Ca ratio, the specific surface area, and the decomposition rate of each gas (propylene, benzene, and toluene) when using a mayenite catalyst supporting cobalt oxide and manufactured by heating at 400°C.

The decomposition rate was found to be closely correlated to the specific surface area, and with all the reaction gases, the maximum decomposition rate was exhibited with a catalyst whose Co/Ca ratio was 0.0344 $((\text{Ca}_{2.9}\text{Co}_{0.1})\text{Al}_2(\text{SiO}_4)_{0.8}(\text{OH})_{8.8})$.

[0019]

Fig. 4 shows the results of subjecting propylene to oxidative decomposition at various reaction temperatures using $((\text{Ca}_{2.9}\text{Co}_{0.1})\text{Al}_2(\text{SiO}_4)_{0.8}(\text{OH})_{8.8})$ as the catalyst. The decomposition rate was 2% at a reaction temperature of 200°C, but the decomposition rate rose along with temperature, reaching 100% at 325°C. The product after decomposition was only CO_2 . H_2O was produced, but was not analyzed. Meanwhile, with a catalyst not substituted with cobalt, that is, just a mayenite, the decomposition rate was zero at a reaction temperature of 325°C, was 2% at 400°C, and reached 100% at 625°C. When a self-combustion experiment was conducted without using a catalyst, propylene began burning only when heated to at least 600°C. The above results mean that it is possible to lower the combustion temperature by using a mayenite as a catalyst, and that the catalytic activity of a mayenite increases by about 200°C when part of its calcium is substituted with cobalt, and the present invention makes it possible to realize even lower

temperatures in these oxidative decomposition reactions. The catalyst of the present invention is useful as an oxidation catalyst for the oxidative decomposition of volatile organic compounds, hydrocarbons, and other such materials to be treated.

[0020]

[Example]

Next, the present invention will now be described in specific terms by giving examples, but the present invention is not limited in any way by the following examples.

Example 1

0.77 g of unslaked lime (as a calcia source), 0.033 g of cobalt hydroxide (Co(OH)_2 ; as a cobalt source), 1.8 g of alumina sol (as an alumina source; containing 20% Al_2O_3), and 0.21 g of amorphous silica (as a silica source) were weighed out, and water was added to bring the total volume up to 14.6 mL. The mixture (suspension) thus prepared was put in an autoclave with a capacity of 25 mL, and heated for 15 hours at 200°C while being stirred at 25 rpm. The system was then allowed to cool to room temperature, filtered, and dried, which gave cobalt-containing hydrogarnet expressed by the compositional formula $(\text{Ca}_{2.9}\text{Co}_{0.1})\text{Al}_2(\text{SiO}_4)_{0.8}(\text{OH})_{8.8}$. This cobalt-containing hydrogarnet with the compositional formula

of $(\text{Ca}_{2.9}\text{CO}_{0.1})\text{Al}_2(\text{SiO}_4)_{0.8}(\text{OH})_{8.8}$ was heated for 5 hours at 400°C, which gave a mayenite catalyst supporting cobalt oxide.

[0021]

Fig. 4 shows the results when the oxidative decomposition of propylene was carried out at various reaction temperatures using a mayenite catalyst supporting cobalt oxide. The catalyst reaction experiment was conducted as follows. The reaction apparatus was a normal pressure, compact, fixed bed, flow through type, the catalyst particle size was 300 to 500 μm , the reaction temperature was from room temperature to 500°C, the reaction gas concentration was 1000 ppm, the flow-through gas was air, the gas flux was 100 mL/min, the space velocity was 10,000 h^{-1} , and gas analysis was performed by gas chromatography (packing material: Porapak P, 5A molsieve, activated carbon, column: 2 m x 3). As a result, the decomposition rate was 2% at a reaction temperature of 200°C, but the decomposition rate rose along with temperature, reaching 100% at 325°C. The product after decomposition was only CO_2 . H_2O was produced, but was not analyzed.

[0022]

Example 2

A catalyst experiment was conducted by the same method as in Example 1, using a mayenite catalyst supporting cobalt oxide prepared by the same method as in Example 1. Fig. 5 shows the results of subjecting benzene to oxidative decomposition at various reaction temperatures. The decomposition rate was 0% at a reaction temperature of 200°C and 13% at 225°C, but the decomposition rate rose along with temperature, reaching 100% at 300°C. The product after decomposition was only CO₂. H₂O was produced, but was not analyzed.

[0023]

Example 3

A catalyst experiment was conducted by the same method as in Example 1, using a mayenite catalyst supporting cobalt oxide prepared by the same method as in Example 1. Fig. 6 shows the results of subjecting toluene to oxidative decomposition at various reaction temperatures. The decomposition rate was 0% at a reaction temperature of 225°C and 25% at 250°C, but the decomposition rate rose along with temperature, reaching 100% at 325°C. The products after decomposition were CO₂ and benzene. H₂O was produced, but was not analyzed.

[0024]

[Effect of Invention]

The present invention relates to a mayenite catalyst supporting cobalt oxide, and to a method for manufacturing this catalyst, and with the present invention, 1) it is possible to provide a catalyst with higher activity than conventional oxidation or combustion catalysts, 2) higher oxidation capability can be achieved at lower temperatures than with conventional catalysts, 3) a mayenite catalyst supporting cobalt oxide can be manufactured by a simple process under lower temperature conditions at least 300°C and no higher than 1000°C, and 4) this catalyst is useful as a way to oxidatively decompose volatile organic compounds and the like.

[Brief Description of The Drawings]

[Fig. 1]

Fig. 1 shows the XRD results for cobalt-containing hydrogarnet synthesized at various Co/Ca ratios from 0 to 0.0714;

[Fig. 2]

Fig. 2 shows the relationship between lattice constant and Co/Ca ratio for cobalt-containing hydrogarnet synthesized at various Co/Ca ratios from 0 to 0.0714;

[Fig. 3]

Fig. 3 shows the relationship between the Co/Ca ratio, the specific surface area (black diamonds), and the decomposition rate of various gases (propylene (white circles), benzene (black squares), and toluene (black triangles)) at a reaction temperature of 300°C when using a mayenite catalyst supporting cobalt oxide;

[Fig. 4]

Fig. 4 shows the results of subjecting propylene to oxidative decomposition at various reaction temperatures using $(\text{Ca}_{2.9}\text{Co}_{0.1})\text{Al}_2(\text{SiO}_4)_{0.8}(\text{OH})_{8.8}$ as the catalyst;

[Fig. 5]

Fig. 5 shows the results of subjecting benzene to oxidative decomposition at various reaction temperatures using $(\text{Ca}_{2.9}\text{Co}_{0.1})\text{Al}_2(\text{SiO}_4)_{0.8}(\text{OH})_{8.8}$ as the catalyst; and

[Fig. 6]

Fig. 6 shows the results of subjecting toluene to oxidative decomposition at various reaction temperatures using $(\text{Ca}_{2.9}\text{Co}_{0.1})\text{Al}_2(\text{SiO}_4)_{0.8}(\text{OH})_{8.8}$ as the catalyst.

[Name of Document] Abstract

[Summary]

[Subject] The present invention provides a novel mayenite catalyst supporting cobalt oxide that has more active oxidation capability at lower temperatures than conventional oxidation or combustion catalysts, a method for manufacturing this catalyst, and a method for the oxidative decomposition of volatile organic compounds with this catalyst.

[Means of solution] A mayenite catalyst supporting cobalt oxide, which is an oxidation or combustion catalyst containing as a constituent component a mayenite that includes or occludes active oxygen (superoxide: O_2^- , peroxide: O_2^{2-}) in its structure, a method for manufacturing the mayenite catalyst supporting cobalt oxide, wherein cobalt-containing hydrogarnet is decomposed by heating, and an oxidative decomposition method, wherein a material to be treated typified by a volatile organic compound is oxidatively decomposed using the mayenite catalyst.

[Figure to be selected] None